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THE MEASUREMENT OF ANXIETY: A NEW METHOD BY VOICE ANALYSIS

G.A. Smith,

Powick Hospital, Worcester, Great Britain.

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Normal voluntary muscular activity in man and other mammals is known to have a superimposed rhythmical tendency, called micro-tremor, at 8-14 Hz (1). Micro-tremor of the muscles of the voice mechanism produces a modulation of the audible voice frequencies, and this modulation is reduced by autonomic nervous system activity under conditions of stress (Dektor C.I.S., 5508 Port Royal Road, Springfield, Va., U.S.A., personal communication). The Dektor Psychological Stress Evaluator (PSE) is equipment which processes tape recordings by filters which enable the lower frequency voice activity to be displayed on a chart. Micro-tremor can be seen as a modulation of this voice activity, and stress can be rated from 0 to 100% according to the degree of absence of the micro-tremor. The aim of the present study was to validate the PSE as a measure of anxiety in a variety of ways.

Methods: *Experiment I* used 9 normal subjects, and took advantage of their being a little nervous when they first entered the room, but relaxing within 10 minutes. Each subject counted aloud repeatedly from 1 to 10 throughout the period, except that half-way he took six deep breaths. Hyperventilation usually increases skin conductance, and it was of interest to see whether it also affected the voice measure. Three of the 1 to 10 counts by each subject were selected for PSE analysis: one at the beginning of the period (A), one just before hyperventilation (B), and one just after hyperventilation (C). Skin conductance measures were also taken from these times, and subjective reports soon afterwards. The PSE charts were rated blind by one rater. Rater reliability obtained by processing recordings twice with different filters (Modes II and III) was 0.76 ($P = 0.02$). Odd-even re-test reliability was $r = 0.69$ ($P = 0.05$), which corrects by Spearman-Brown to $r = 0.82$.

Experiment II used the tape recordings from Experiment I, from which were selected 16 pairs of utterances in which one utterance showed PSE stress and the other did not. 13 further normal subjects listened and tried to pick out the stressed utterance of each pair. Listeners tended to pick out the first utterance ($P = 0.01$, 2-tail) as the "tense" one, so position was designed to be balanced.

Experiment III used 15 neurotic patients being treated with a variety of behavioural techniques. Each patient read out twice a list of ten short phrases referring to common life-stressors: marriage, job, etc., including some referring to the individual's presenting fears. Re-test reliability of single items for an individual was low, the mean Spearman rho for the 15 patients being +0.24, but the distribution of these 15 rho's had a mean significantly greater than zero ($P = 0.02$, 1-tail).

	(A) Beginning of experiment	(B) Before hyperventilation	(C) After hyperventilation
Self-rating of tension (0 to 3) or relaxation (0 to -3)	1.0 ± 0.5	0.44 ± 0.7	-0.11 ± 0.8
Palmar skin current (μA)	19.0 ± 9.5	18.2 ± 10.1	22.6 ± 11.9
Voice stress (%)	22.2 ± 7.6	18.3 ± 9.1	17.9 ± 8.0

Results: *Experiment I.* Using a t-test for differences between dependent measures, it was seen that the manipulation of stress was successful (table). Subjects reported a decrease in tension from point A to point B, and from point B to C ($P = 0.025$, 1-tail, both differences). Skin conductance did not change from A to B, but did increase from B to C as hypothesised ($P = 0.025$, 1-tail). Voice stress decreased as hypothesised from A to B ($P = 0.05$, 1-tail), but the decrease from B to C was not significant. The decrease from A to C was significant at the $P < 0.01$ level. These results support the PSE as a valid measure of states of stress, but with some loss of validity if hyperventilation is present. Its disruption by hyperventilation was much less severe than the disruption of the skin conductance measure. Indeed it looked as though skin conductance was invalidated even by the extra breathing involved in speaking.

Experiment II. By chance, the listeners would be correct 8 times out of 16. Their overall performance was not significantly better than this. However, analysis of their performance on pairs with large stress differences between the two utterances showed a better than chance accuracy ($P = 0.03$, 1-tail). Their accuracy was 65%, compared with a 50% chance. This result supports the PSE as measuring something which, with difficulty, can be heard as tension.

Experiment III. The mean stress on items referring to presenting fears was 37.8% ± 6.5, and on the other items 33.3% ± 4.8. These were significantly different as hypothesised ($P = 0.01$, 1-tail). It will be seen that the scores of neurotics were much greater than those of normals in Experiment I, although this difference could also be due to the content of the utterances. If a patient's presenting complaints were not his true problems, then this might jeopardise treatment. Differences between stress scores on presenting fear items and those on other items were rank-order correlated with degree of improvement. This gave a positive correlation, rho = +0.41, but it was not significant. Hence any indication that dissimulation reduced treatment success was not clear.

These three experiments indicate the usefulness of the PSE as a measure of both trait anxiety and state anxiety in talking persons. Two areas are suggested for further study: the communication of stress from speakers to listeners, and the identification of unrevealed stressors

1. Lippold, O.C.J. (1967) in *A Manual of Psychophysiological Methods* (Venables and Martin, eds.), Ch. 8. North Holland Publishing Co., Amsterdam

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